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(54) Fluid pressure actuator.

(57) An actuator for a fluid pressure system includes a foot pedal (50) pivotally connected to a support structure (51) for movement away from and into a rest position. A piston-cylinder assembly (2) has a piston (9) slidably mounted within a bore (8) of a cylinder member (3) and a pressure chamber (14) formed at least in part within said member. Movement of said piston in one direction relative to said member is operable to cause a reduction in the volumetric size of said chamber. The assembly (2) is pivotally connected to the foot pedal and the support structure respectively, and the pivotal connection to the foot pedal is located intermediate the ends of a lever forming part of the foot pedal. The two pivotable connections with the support structure are spaced apart so that movement of said pedal away from said rest position causes movement of said piston in the one direction.

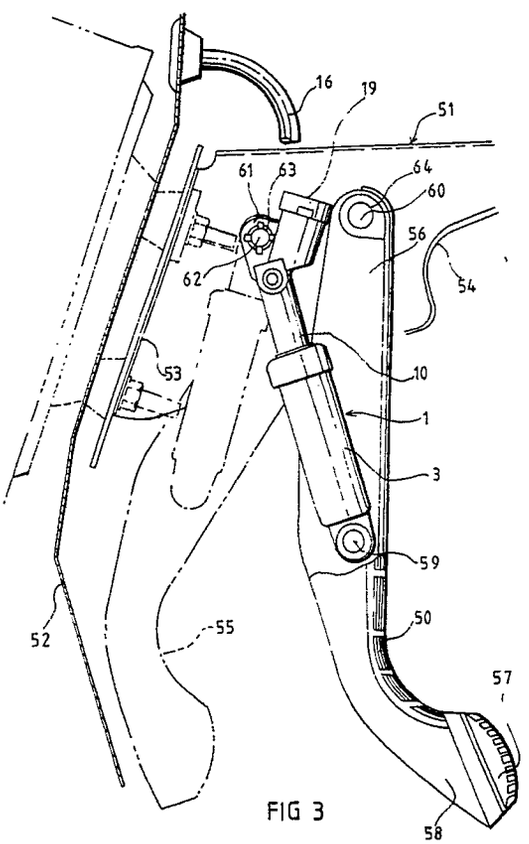

FIG 3

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This invention relates to actuators for fluid pressure systems. An example system to which the invention is applicable is a hydraulically operated clutch system, but the invention has other applications including hydraulic brake systems.

Hydraulic clutch systems typically include a master cylinder which is operated to generate the primary driving force and therefore functions as the system actuator, and a slave cylinder which responds to that force so as to cause operation of the clutch. A foot pedal is generally used as the device through which operation of the master cylinder is achieved. A reservoir containing a supply of hydraulic fluid is connected into the system, usually to the master cylinder, so as to make up for fluid losses which may occur over a period of time.

It is usual to mount the foot pedal and the master cylinder on respective opposite sides of the vehicle fire wall, and the master cylinder needs to be firmly mounted so that the forces generated (primarily tensile) during operation are fully sustainable, i.e. since any deflection of the master cylinder or its mounting will disturb the effectiveness of the system. However, the requirement to provide a rigid mounting of the master cylinder presents difficulties and adds to manufacturing and installation costs.

US-A-2 525 740 & FR-A-86 139 both disclose an actuator assembly fixed to the end of a brake pedal linkage.

An object of the present invention is to provide a simple and yet effective actuator for a pedal operated fluid pressure system. In one particular form, it is an object of the invention to provide an improved master cylinder for use in a hydraulic fluid system, such as a clutch or brake system. It is another object of the invention to provide an improved actuator assembly which is easy to assemble and disassemble and which requires as few parts as possible.

According to the invention there is provided an actuator for a fluid pressure system including

a foot pedal pivotally connected to a support structure for movement away from and into a rest position;

a piston-cylinder assembly having a piston slidably mounted within a bore of a cylinder member and a pressure chamber formed at least in part within said member, movement of said piston in one direction relative to said member being operable to cause a reduction in the volumetric size of said chamber, said assembly being pivotally connected to the foot pedal and the support structure respectively, characterized in that

the pivotal connection to the foot pedal is located intermediate the ends of a lever forming part of the foot pedal, and that the two said pivotable connections with the support structure are spaced apart so that movement of said pedal away from said rest position causes movement of said piston in said one direction.

The actuator assembly may be utilized with a foot pedal to provide a pedal actuator suitable for use as a brake or clutch pedal or like applications.

An actuator and pedal actuator having such features can be constructed in various ways, but one example of an actuator according to the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 shows a cross-sectional side view of an actuator;

Figure 2 shows an enlarged cross-sectional side view of a part of the actuator of Figure 1;

Figure 3 shows a part cross-sectional side view of a pedal assembly including the actuator or Figure 1; and,

Figure 4 shows a part cross-sectional front view of the assembly of Figure 3.

It will be convenient to hereinafter describe the invention as applied to a vehicle hydraulic clutch system, but as previously explained that is not the only application of the invention.

The actuator 1 shown in Figure 1 comprises a master cylinder 2 which is composed wholly or substantially of plastics material. Different plastics materials may be selected for different components of the actuator according to the respective use conditions of those components.

The body of the acutator shown is in the form of a tubular member or cylinder 3 which is open at one end 4 and closed at the other end 5 by an end wall 6. A mounting flange 7 projects outwardly from that end wall 6 for a reason hereinafter made clear. The interior of the cylinder 3 is defined by a cylindrical bore 8 which is preferably of constant diameter over at least a substantial part of its length.

A piston 9 is slidably mounted in the cylinder bore 8 and is connected to a stem 10 which projects axially out of the cylinder 3 through the open end thereof. Preferably, the piston 9 and the stem 10 are integrally formed from a suitable plastics material. Sealing means are provided on the piston 9 for sealing sliding engagement with the surface of the surrounding bore 8. In the embodiment shown this sealing means comprises a pair of O-ring seals 11. Any suitable stop means 12 may be provided at or adjacent the open end 4 of the cylinder 3 to restrain the piston 9 against movement through that open end 4. In that regard, the stem 10 has a diameter less than that of the piston 9.

Biasing means such as a coil compression spring 13 acts between the piston 9 and the body end wall 6 so as normally to urge the piston 9 towards a rest position at which it is adjacent the

body open end 4 and engages the stop means 12 secured to the cylinder 3. The part of the cylinder bore 8 between the piston 9 and the body end wall 6 forms a portion of a pressure chamber 14. In the arrangement shown, another portion of that chamber 14 is formed by an axial bore 15 formed in the piston 9 and extending into the associated stem 10. That bore 15 extends through the piston end adjacent the cylinder end wall 6. The pressure chamber 14 is connected to an outlet line 16 through an outlet port 17 provided through a side wall 18 of the piston stem 10, at a location remote from the end of the stem 10 which is connected to the piston 9.

A fluid supply reservoir 19 is connected to the hollow stem 10 rather than direct to the cylinder body 3 as in prior actuators. That reservoir 19 includes a hollow body 20 which may be formed integrally with the end of the stem 10 which is remote from the piston 9. A transverse wall 21 separates the interior of the reservoir 19 from the stem bore 15 and an orifice 22 is provided through that wall 21 to permit transfer of fluid between the reservoir 19 and the pressure chamber 14. Fluid may be introduced into the reservoir 19 through an access opening positioned remote from the piston stem 10, and a removable closure 24 is provided over that opening.

Valve means 25, shown in detail in Figure 2, is associated with the orifice 22 and is operable to close that orifice 22 when the actuator 1 is being operated to cause the piston 9 to move towards the end wall 6 of the cylinder body 3. It is preferred that the valve means 25 is retained in an orifice open position when the piston 9 is at its rest position so that fluid can pass from the reservoir 19 to the pressure chamber 14 in order to make up for any losses occurring during operation of the actuator.

In the form shown, the valve means 25 includes a closure element 26 which is located within the piston stem bore 15 and includes a head portion 27 arranged to engage a annular valve seat 28 extending around the orifice 22. That valve seat 28 is depicted as having a frusto-conical form, but that is not essential. The head portion 27 includes a part-spherical section 29 which forms a terminal extremity of the closure element 26 and which is connected to a circular flange 30 or boss through a neck 31 of reduced diameter. A flexible cap 32 of rubber or other suitable elastomeric material is snap-engaged over that part-spherical section 29 so as to form the valve seat engaging surface of the closure element 26.

Any suitable retaining means may be provided to retain the closure element 26 in an orifice open position when the piston 9 is at its rest position. In the construction shown, that retaining means 33 includes a tubular member 34 which is held against or secured to the end wall 6 of the cylinder body 3, and a rod 35 which connects the head portion 27 to that tubular member 34. The rod 35 may be formed integrally with the head portion 27 and extends axially from that head portion 27 towards the cylinder body end wall 6. The tubular member 34 extends axially from that end wall 6 towards the cylinder open end 4 and in the arrangement shown projects into the piston bore 15 with clearance.

The connection between the rod 35 and the tubular member 34 is such as to permit limited relative axial movement between those components. In the depicted arrangement, the rod 35 extends through an opening 36 in the adjacent end of the tubular member 34 and is slidable within that opening 36 to permit relative axial movement between the rod 35 and tubular member 34. The end portion of the rod 35 located within the tubular member 34 is provided with an enlargement 37 which is engageable with a transverse abutment surface 38 of the tubular member 34. The enlargement 37 and abutment surface 38 engage when the piston 9 is in its rest position and thereby hold the head portion 27 clear of the valve seat 28 so that fluid can pass between the reservoir 19 and the pressure chamber 14.

When the actuator 1 is operated, the piston 9 moves further into the cylinder body 3 and as a consequence the axial distance between the valve seat 28 and the abutment surface 38 is reduced. That reduction permits the closure element head portion 27 to engage the valve seat 28 and such engagement preferably occurs shortly after operation commences. Continued inward movement of the piston 9 results in the rod 35 moving further axially into the tubular member 34, and adequate radial and axial clearance is provided for that purpose.

The tubular member 34 may be held against the cylinder end wall 6 by means of the biasing spring 13, and in that event may have a laterally projecting flange 39 at its terminal end to provide a surface against which the spring 13 can engage. Any suitable means may be provided to permit fluid to pass between the interior of the tubular member 34 and the portionof the pressure chamber 14 surrounding it.

In the embodiment shown, one or more longitudinally extending slots 40 are formed through the side wall of the tubular member 34.

Guide means 41 is preferably provided within the piston stem bore 15 to ensure that the head portion 27 of the closure element 26 is correctly aligned with the valve seat 28. That guide means 41 may include a sleeve 42 positioned within the end of the stem bore 15 adjacent the reservoir 19 and which slidably contains the head portion 27.

The guide sleeve 42 also functions as a stop which limits the degree of movement of the head portion 27 away from the valve seat 28. Opposed surfaces of the sleeve 42 and head portion 27 engage when the head portion 27 and valve seat 28 are separated to an extent sufficient to permit adequate fluid transfer between the reservoir 19 and the pressure chamber 14.

A coil compression spring 43 acts between the guide sleeve 42 and the tubular member 34 so as to hold the sleeve 42 resiliently against the transverse wall 21. That spring 43 allows the sleeve 42 to move away from the transverse wall 21 in the event that axial expansion of the actuator 1 exceeds that at which the stop 12 becomes operative.

The head portion 27 of the closure element 26 is urged against the valve seat 28 by pressure of the fluid within the pressure chamber 14. For that purpose adequate clearance is provided between the closure member rod 35 and the guide sleeve 42 to permit fluid within the stem bore 42 to impinge against the head portion 27. Preferably, and as shown, a suitable spring 44 acts between the guide sleeve 42 and the head portion 27 to augment that valve closing influence.

It is preferred that the outlet port 17 is located in a portion of the stem side wall 18 which surrounds the guide sleeve 42. Appropriate access passage means 45 may be provided in that sleeve 42 or side wall 18 to ensure proper communication between the outlet port 17 and the pressure chamber 14. The end portion 46 of the tubular member 34 adjacent the valve seat 28 is of reduced diameter to provide a shoulder 47 against which the spring 43 acting on the guide sleeve 42 can engage. One or more openings 48 may be provided through the side wall of that end portion 46 to ensure proper communication between the stem bore 15 and the interior of the tubular member 34.

An actuator 1 as described has important advantages over prior actuators. It is of particularly simple and compact construction, and factors which contribute to that result are the hollow piston stem 10 and the connection of the reservoir 19 to that stem 10 rather than directly to the cylinder body 3. Another advantage arises from the particular valve means described. That valve means provides for only one possible leakage path between the reservoir 19 and the pressure chamber 14, whereas two or more such paths generally exist in prior arrangements.

The actuator 1 of the invention is adapted to be included in a simple and effective actuator assembly. The assembly depicted in Figures 3 and 4 of the drawings includes a foot pedal 50 which is arranged to cause operation of the actuator 1.

As shown, the actuator 1 and the foot pedal 50 are each connected to a common mounting bracket 51 which is adapted to be secured to a vehicle fire wall 52, for example. The bracket 51 in one form has a base 53 and a pair of side walls 54 upstanding from that base. The foot pedal 50 and the actuator 1 are located between those side walls 54 and each is independently pivotally connected to the bracket 51 for movement towards and away from the bracket base 53. The foot pedal 50 and actuator 1 are also pivotally connected to one another and the arrangement is such that pivotal movement of the foot pedal 50 causes reduction in the axial length of the actuator 1 and thereby operates the actuator 1. The depressed position of the foot pedal 50 is depicted in Figure 3 by dotted lines 55.

The pedal 50 has one end 56 pivotally connected to the bracket 51 and has a foot engaging pad 57 at its opposite end 58. The body 3 of the actuator 1 is pivotally connected to the foot pedal 50 through the mounting flange 7, and that connection is at a location between the ends 56 and 58 of the pedal 60. Preferably, the pedal 50 is of channel shape between its end and the actuator body 3 is at least partially located within that channel under all circumstances of use. The axis 59 of the pivotal connection between the actuator and pedal is substantially parallel to the axis 60 of the pivot about which the pedal 50 moves.

A mounting flange 61 is provided at the end of the piston stem 10 remote from the actuator body 3 and that flange 61 is used to connect the stem 10 pivotally to the mounting bracket 51. Once again the pivot axis 62 is substantially parallel to the pivot axis 60 of the pedal. In order to achieve the desired operation of the actuator 1, it is generally preferred to locate the stem pivot 63 adjacent the pedal pivot 64, but at a location closer to the bracket base 53. The arrangement is such that inward swinging movement of the pedal to the position shown by lines 55 causes the actuator piston 9 to move further into the cylinder body 3 thereby pressurising the fluid in the pressure chamber 14.

It will be appreciated that the pedal 50 and actuator 1 need not be connected to a bracket 51 as described. Furthermore, each may be independently connected to a support structure rather than through a common bracket.

An assembly as described is extremely compact and has the advantage of placing the actuator 1 under compression when in use. There is the further advantage of having the reservoir 19 located in direct association with the actuator 1 rather than being remote therefrom.

In our parent application, EP-A-0293082, we claim a fluid pressure actuator comprising a body having a cylindrical bore therein; a piston having a head portion slidably mounted in the bore and a

stem which projects out of the body through one end thereof; a pressure chamber having a first part formed within the body between the head portion of the piston and an end wall of the body at the end thereof remote from the stem, and a second part formed by a passage within the piston; a fluid reservoir separated from the pressure chamber by a transverse wall formed across the passage at an end of the passage remote from the head end of the piston; orifice means connecting the interior of the fluid reservoir with the passage, through the transverse wall; a valve closure member provided in the passage, operable to close the orifice means in response to movement of the piston towards the end wall; a tie operable to cause the valve closure member to lift off the orifice when the piston moves to a rest position remote from the end wall of the body; a compression spring acting between the piston and the end wall and biasing the piston into the rest position; and, stop means on the body for limiting movement of the piston out of the body.

Claims

1. An actuator for a fluid pressure system including

   a foot pedal (50) pivotally connected to a support structure (51) for movement away from and into a rest position;

   a piston-cylinder assembly (2) having a piston (9) slidably mounted within a bore (8) of a cylinder member (3) and a pressure chamber (14) formed at least in part within said member, movement of said piston in one direction relative to said member being operable to cause a reduction in the volumetric size of said chamber, said assembly (2) being pivotally connected to the foot pedal and the support structure respectively, characterized in that

   the pivotal connection to the foot pedal is located intermediate the ends of a lever forming part of the foot pedal, and that the two said pivotable connections with the support structure are spaced apart so that movement of said pedal away from said rest position causes movement of said piston in said one direction.

2. An actuator according to claim 1, wherein said assembly includes a fluid inlet (22) and a fluid outlet (17), said outlet is connectable to means to be operated by said actuator, a fluid reservoir (19) is connected to said inlet, and valve means (25) is operable to control passage of fluid through said inlet.

3. An actuator according to claim 2, wherein said piston has a head portion slidably mounted in said bore and a stem (10) which projects out of said member (3) through one end thereof,

   said pressure chamber has a first part formed within said member (3) between said head portion and an end wall (6) of said member at the end thereof remote from said one end, a passage (15) within said piston forming another part of said pressure chamber and being in communication with said first part of the pressure chamber,

   orifice means (22) connects the interior of said fluid reservoir with said passage,

   and said valve means is operable to close said orifice means in response to movement of said piston towards said end wall.

4. An actuator according to claim 2 or 3, wherein said valve means is biased to a closed position.

5. An actuator according to claim 3, wherein said valve means comprises a valve closure member (26) linked to said cylinder member (3) through a tie (35), said tie causing said valve closure member to lift off said orifice when the piston moves to a rest position remote from the end wall of the cylinder member.

6. An actuator according to any preceding claim, wherein said piston is biased by means of a spring (13) to said rest position.

7. An actuator according to claim 6, wherein said spring comprises a compression spring which acts between said piston and said end wall, and said cylinder member is provided with a stop formation (12) for limiting movement of the piston out of the bore.

8. An actuator according to claim 3, wherein the reservoir and piston stem are separated by a transverse wall (21) having said orifice therethrough, said orifice defining a valve seat (28).

9. An actuator according to claim 3, wherein said valve means comprises a valve closure member (26) having a part spherical head (29) covered with a cap (32) of elastomeric material.

10. An actuator according to claim 9, wherein the head is connected to a rod (35), said rod extends towards the chamber and is coupled with a bracket (34) fixed to the cylinder member, the connection between the rod and the bracket enabling relative movement between the rod and the bracket when the piston is

caused to move into the cylinder, but will lift the head off the orifice as the piston moves into a rest position remote from the end wall of the cylinder member.

11. An actuator according to claim 10, wherein the bracket is held to the end wall of the cylinder member by a compression spring (13) which acts between said end wall and the piston to bias the piston to the rest position.

12. An actuator according to claim 3, wherein the valve means is located within the passage in the piston stem (10) and a guide means (41) is provided in said passage to guide the valve means towards the orifice.

13. An actuator according to claim 12, wherein the guide means is adapted to limit the degree of movement of the valve means away from the orifice.

14. An actuator according to claim 13, wherein the guide means is movable within the passage and is biased by means of a spring (44) towards the orifice end of the passage.

15. An actuator according to claim 3, wherein the fluid outlet is located in the stem of the piston adjacent the orifice end of said piston.

16. An actuator according to claim 3, wherein seal means (11) are provided between the piston and the bore, said seal means comprising an elastomeric ring seal located in an annular groove formed around the piston.

17. An actuator according to claim 3, wherein the piston and the body are both formed of a plastic material.

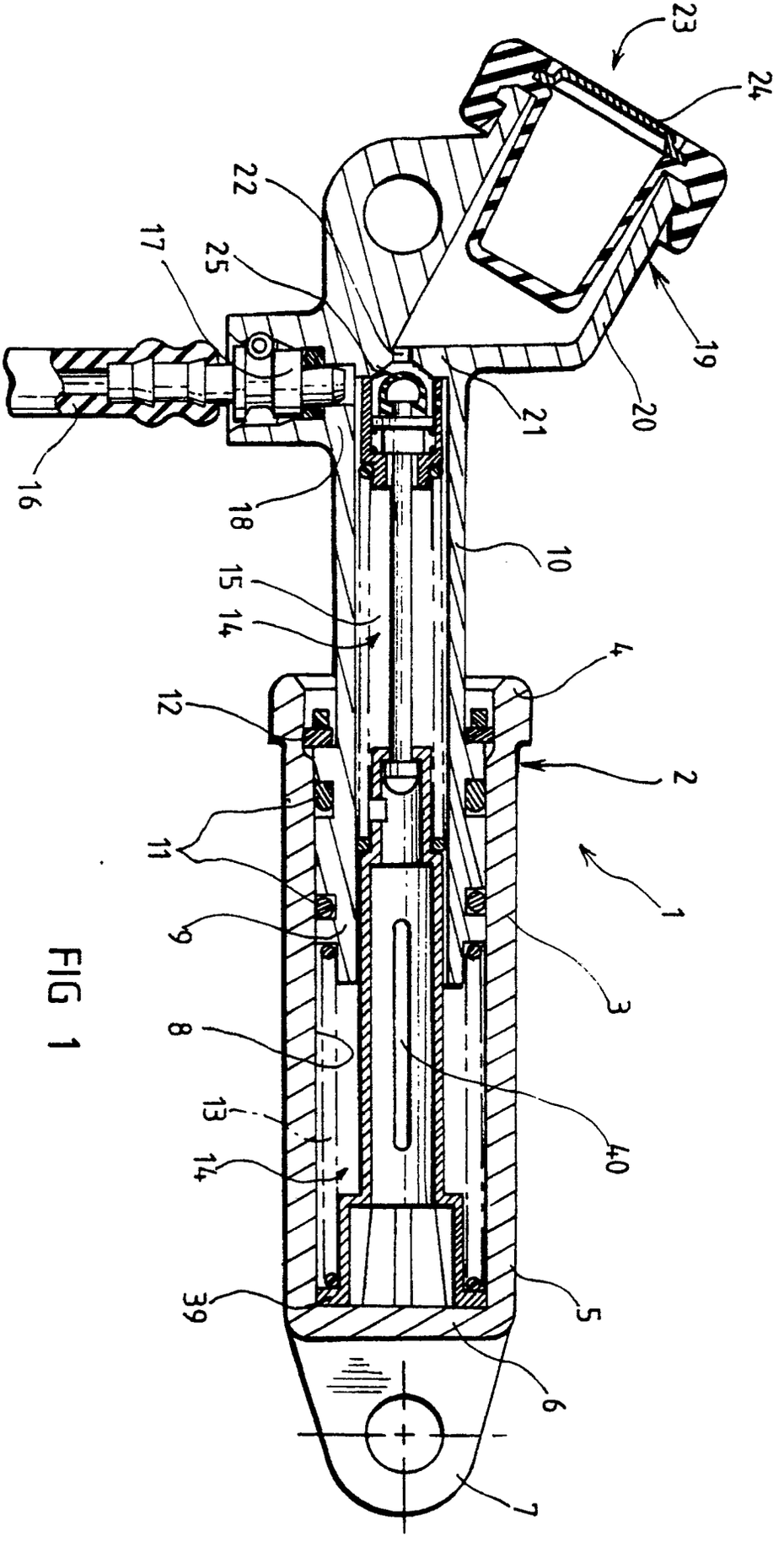

FIG 1

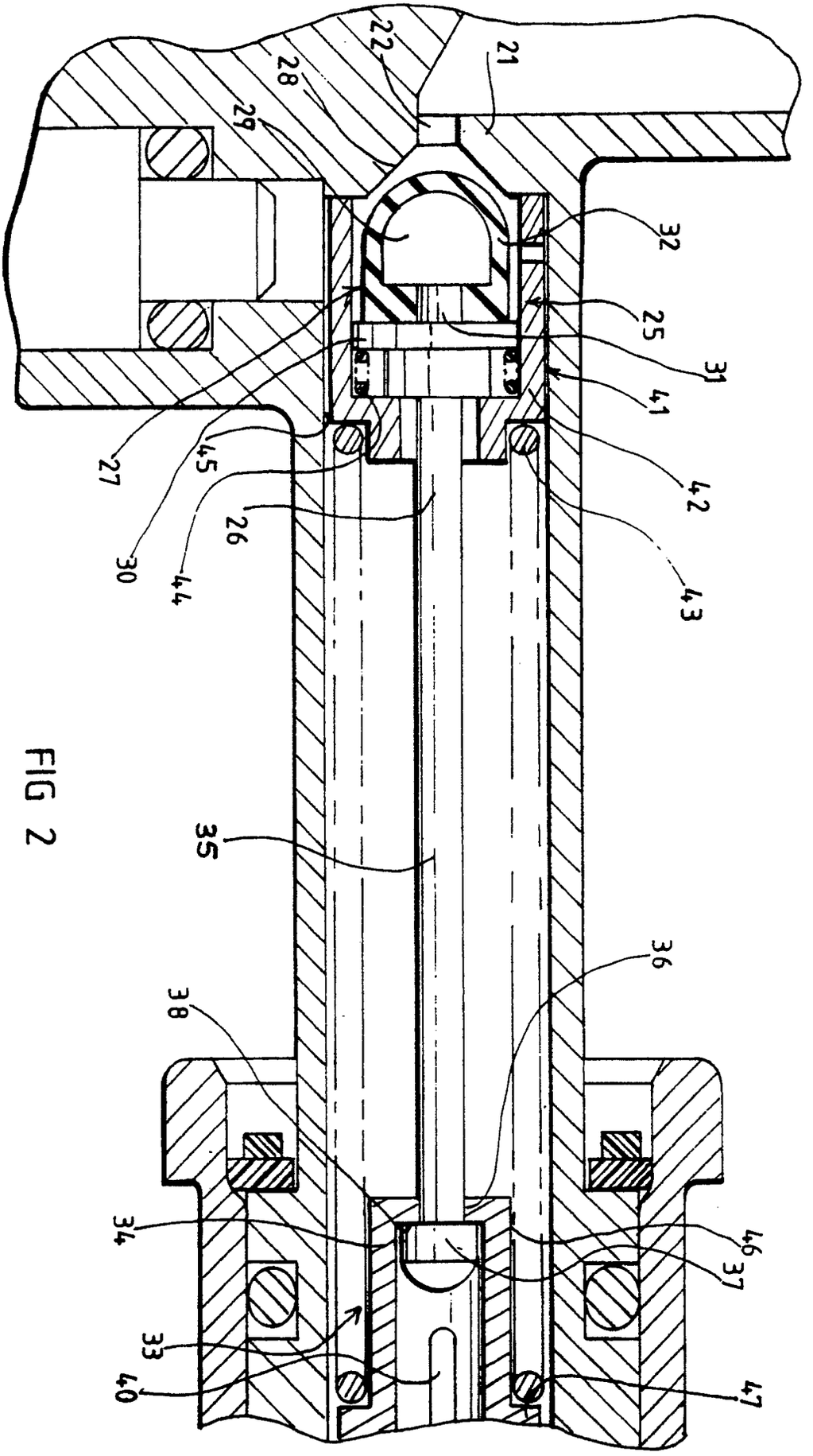

FIG 2

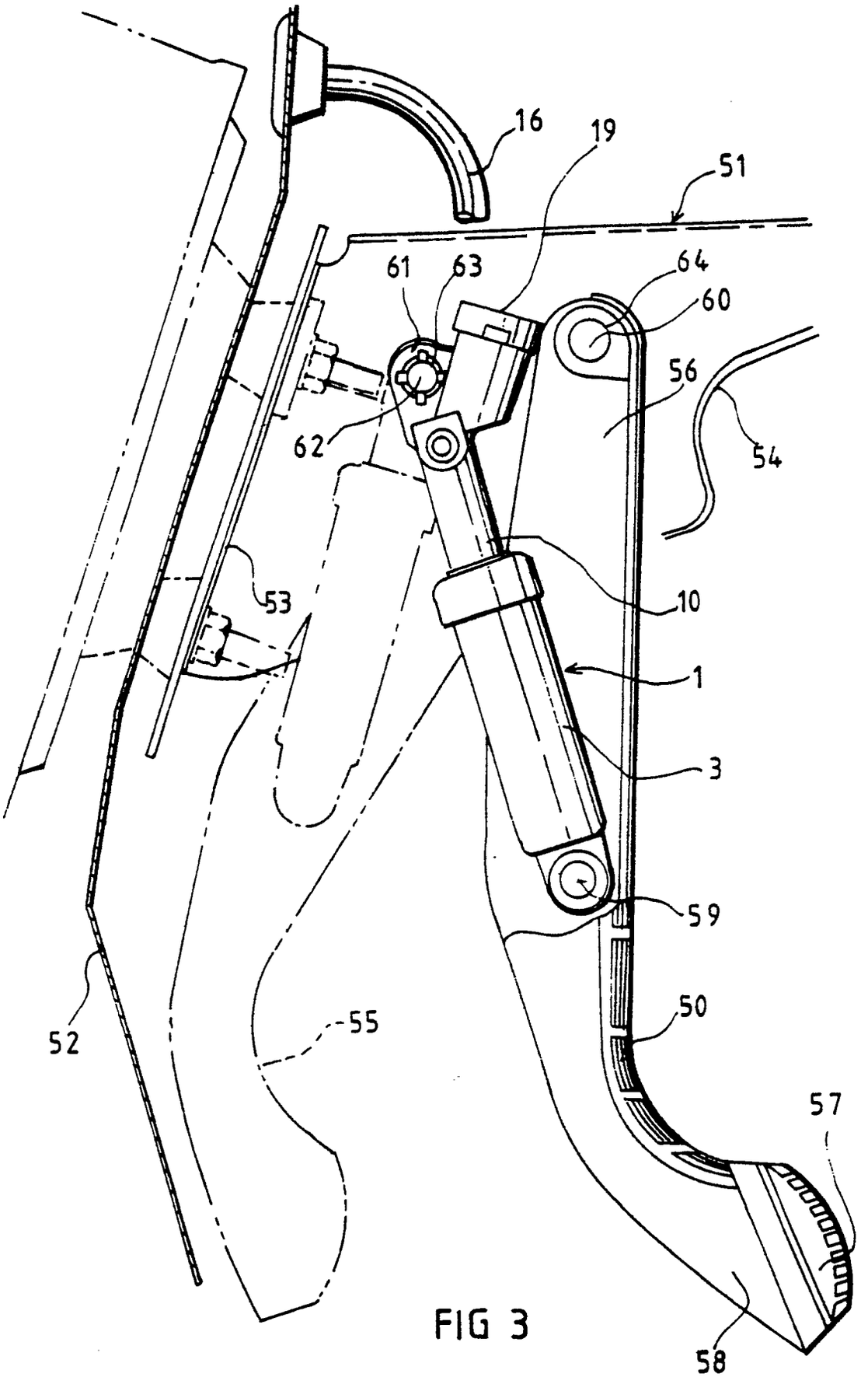

FIG 3

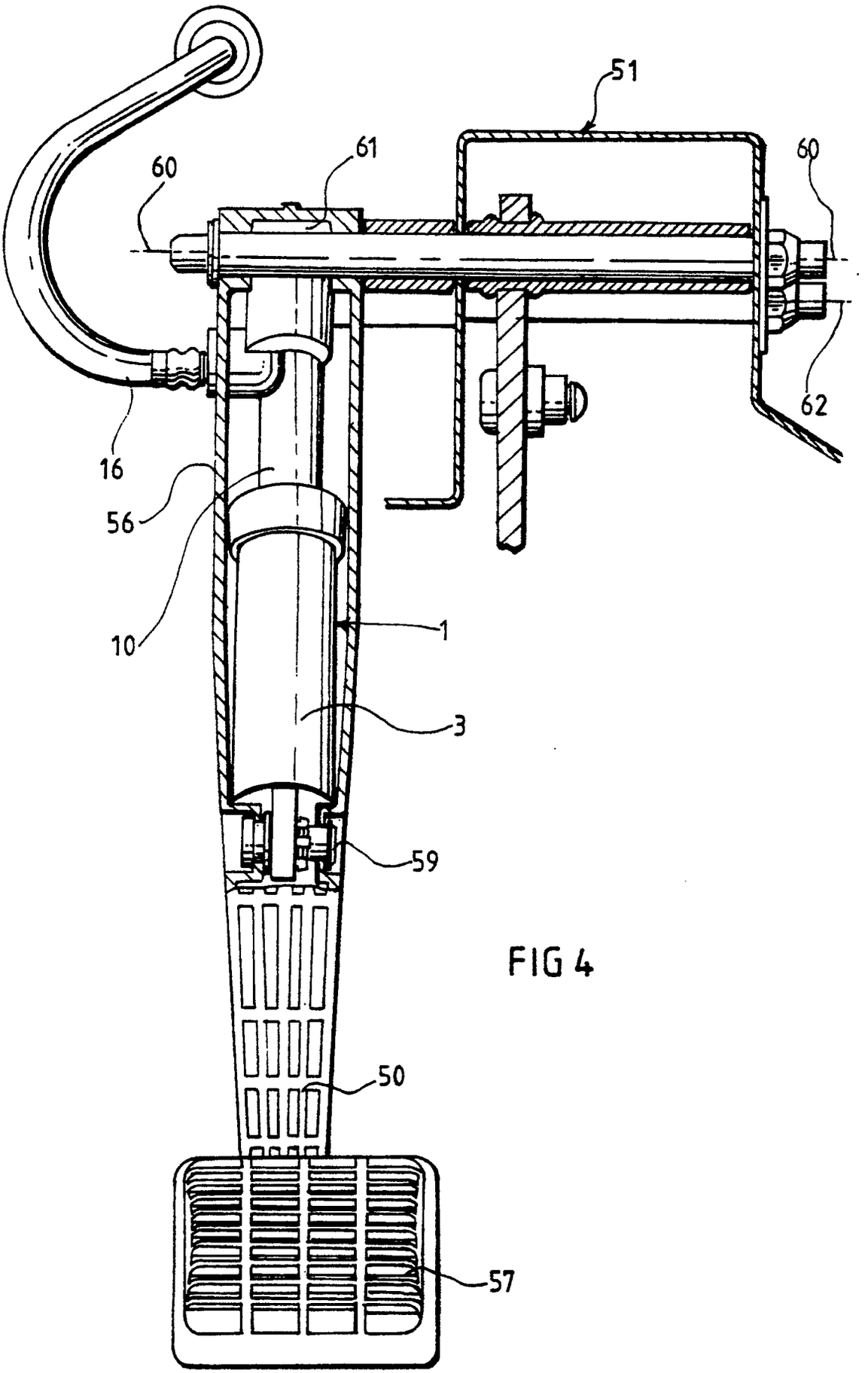

FIG 4